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The Chemistry and Bioaccumulation of Copper and Other Heavy Metals By Phytoplankton in the Water Column of San Diego Harbor and Its Relationship to Ecological Assessment and Water Quality

James W. Moffett
Department of Marine Chemistry and Geochemistry
Woods Hole Oceanographic Institution
Woods Hole MA 02543
phone: (508) 289-3218 fax: (508) 457-2164 email: jmoffett@whoi.edu
Award #: N000149710718
http://www.whoi.edu

LONG-TERM GOALS

My long term objective for AASERT Awards has been to attract excellent graduate students into areas of environmental quality that are relevant to the Navy's interest. This AASERT was used to support a student interested in contaminant fate and transport in systems highly relevant to the Harbor Processes Program.

OBJECTIVES

The objectives of this project were ultimately determined by the student's dissertation project. The student, Elizabeth Kujawinski, has been studying the role of protozoan grazing on the fate and transport of organic contaminants, specifically PCBs. Protozoans are important components of microbial asemblages in many carbon-rich contaminated waters. Ingestion of bacterial sized particles by these organisms can have a major impact on particle size distribution and chemistry. She is interested in the role of the grazing process in bioaccumulation and as a source of colloidal organic that is important in contaminant mobility.

APPROACH

The approach is to study the partitioning of a suite of PCB congeners between bacterial, protozoan and colloidal particles in cultures of actively grazing marine protozoans and bacteria. The processes are characterized by filtration, headspace partitioning, and radiotracer measurements, and ancillary measurements of organic carbon concentration and composition, and surfactant concentrations are also being made.

WORK COMPLETED

Cultures of 3 representative protozoans have been studied using the bacterium *Halomonas halodurans* as prey. A suite of PCB congeners were added to these systems and the kinetics of partitioning between bacterial and protist size classes was measured to distinguish between grazing and equilibrium partitioning as mechanisms for PCB accumulation in the protozoans.

Protozoan grazers can "clear" a dense bacterial culture in several days. The resulting media has high surfactant concentrations. In order to evaluate grazers as a source of surfactants, measurements of surfactant concentration, normalized to a Triton X-100 standard, were made using a standard polarographic technique.
Filtrates from "cleared" cultures were equilibrated with C-14 labelled PCBs in specially designed vessels to measure changes in headspace partitioning resulting from colloidal binding of PCBs. The concentration of colloidal organic C in these experiments was measured, and the lipid composition (which might contribute to PCB partitioning) was measured as well.

RESULTS

Partitioning of PCBs amongst these size classes was shown to be dominated by physical-chemical processes rather than grazing, even for the most hydrophobic PCB congeners. This is a consequence of the high surface area to volume ratios of these unicellular organisms, and large cross membrane fluxes arising from preconcentration within phospholipid bilayers.

Ingestion of bacteria was associated with large production of surfactant material. Less than 2% of this material was lipid in composition. There were significant interspecies differences. Interestingly, the protists that produced the highest surfactant levels were the least effective at dissolving refractory iron oxide phases (from the thesis work of my former student K. Barbeau – also an AASERT recipient). Results suggests that protozoan grazing may be a major source of surfactant material in seawater.

The surfactant material was correlated with PCB partitioning in culture filtrates, suggesting that common materials are involved. Partition coefficients (Koc) for these samples were 7-10 fold higher than previous measurements in seawater. This suggests that materials derived directly from grazing may be more important in PCB mobility than more refractory materials in the water column. Thus areas of localized, high grazing activity might show enhanced PCB mobility.

IMPACT/APPLICATIONS

Protozoan grazing is especially important in C-rich, nutrient poor regimes, including systems with high levels of hydrocarbon contamination. Many systems established for bioremediation have these characteristics. The contribution of protozoans to the overall chemistry of such regimes and their influence on contaminant transport will need to be considered.

PUBLICATIONS

Kujawinski, E.B. , J.W. Moffett and J.W. Farrington (1999). The importance of passive diffusion in the uptake of PCBs by phagotrophic protozoa. Submitted to Applied and Environmental Microbiology.